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ABSTRACT

Textons are elongated blobs of specific color, angular orientation, ends of lines, and crossings of line segments that are proposed to be the perceptual building blocks of the visual system. A study was conducted to explore the relative memorability of different types and arrangements of textons, exploring the time course for the discrimination and forgetting of textons for infants, and the relationship between the duration for which different textons are remembered and their differential discriminability for adults. Subjects for the experiment included 120 3-month-old infants, who were trained to kick to move one of three mobiles, each of which was composed of seven pink wooden blocks, on each side of which were displayed computer-generated, overlapping black lines arranged as either L, T, or +. Training sessions were followed by a delayed recognition test. Study findings included the following: (1) infants remember +'s (which are preattentively discriminated by adults) more than twice as long as L's or T's (which are not); (2) infants discriminate a change in a single texton type for as long as the original mobile can cue retrieval of the task; and (3) infants' discrimination of L's and T's from +'s is not the result of differences in the subjective sizes of these stimuli nor differences in characters' orientation or position. (AC)

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ED 369 483

INFANT MEMORY FOR PRIMITIVE PERCEPTUAL FEATURES

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Background

Textons, as characterized by Julesz (1984) in his theory of visual processing, are elongated blobs of specific color, angular orientation, ends of lines (terminators), and crossings of line segments. These textons are proposed to be the perceptual building blocks of the visual system. Specifically, Julesz found that when a field of +s and a field of *T*s were embedded in a surrounding area of *L*s, effortless discrimination of the + from the *L* occurred due to the + having a feature which the *L* does not have, namely, the line crossing. However, discriminating *T*s from *L*s did not occur because, as nonoverlapping line segments, they have identical features. That these features are in different spatial relations is presumably not detected by the preattentive visual system.

Previous studies have shown that infants, trained in the mobile conjugate reinforcement paradigm, forget the details of the original mobile after a delay of 3 days and respond robustly whether the test mobile is the same or different (Rovee-Collier & Sullivan, 1980). Complete forgetting of the contingency occurs 6-8 days after training (Sullivan, Rovee-Collier, & Tynes, 1979). If textons are primitive perceptual units then perhaps certain textons will be discriminated and remembered longer than others.

The Problem

To date, no one has explored the relative memorability of different types and arrangements of textons despite the fact that the recognition of the patterns constructed from them depends on the degree of the match with the contents of long-term memory. In the present study, therefore, we explored the time course for the discrimination and forgetting of selected textons. In addition, we asked whether there is a relation between the duration for which different textons are remembered and their differential discriminability by adults.

Procedure

One-hundred-twenty 3-month-old infants (n=6/group), served as subjects in all experiments. All were trained to kick to move one of three mobiles, each of which was composed of seven pink wooden blocks, on each side of which were displayed two identical 2.5 x 7.5-cm

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computer-generated, overlapping black lines arranged as either an *L*, *T*, or + (see Figure 1a, b, and c).

Training sessions lasted for 15 min on each of 2 consecutive days and were followed after a specified retention interval by a delayed recognition test. The first and last 3 min of each training session were nonreinforcement phases, and the intervening 9 min was a reinforcement (acquisition) phase. The initial nonreinforcement phase of session 1 was a baseline phase during which the infant's unlearned kick rate was measured. The final nonreinforcement period of session 2 was an immediate retention test during which the infant's final training level and retention were assessed after zero delay. The long-term retention test, also during a nonreinforcement phase, lasted 3 min. At this time, the infant's response rate was again measured but after a delay.

Experiment 1A

Experiment 1A was designed to examine whether some textons are more memorable than others. To this end, infants were trained with mobiles displaying either *L*s, *T*s, or +s and were then tested with one of the other two mobiles either 1, 3, 5, or 7 days later. Additional infants were tested after delays of 1, 7, or 9 days with the original training mobile (+s).

Results indicated that infants trained with either *L*s or *T*s and tested with the other showed excellent retention 1 day after training, partial retention after 3, and complete forgetting after only 5 (see Figure 2). In contrast, infants trained and tested with +s exhibited near-perfect retention after 1 and 7 days but not after 9 days (see Figure 3). These data suggest that *L*s and *T*s are not particularly memorable, while +s, perhaps due to the unique and/or additional texton (the line crossing), are remembered more than twice as long.

Experiment 1B

To test the possibility that the poor retention of *L*s and *T*s in Experiment 1A was the result of an insufficient match between the test cue and the training representation, infants were trained and tested with the same mobile (either *L*s or *T*s) after 7 days--the longest delay after which +s had been remembered. However, infants again exhibited no retention after 7 days, even though their training and test mobiles were identical (see Figure 2). These data eliminate the possibility that infants' poor retention of *L*s or *T*s in Experiment 1A resulted from having been trained with *L*s but tested with *T*s (and vice versa) and confirm that *L*s and *T*s are not particularly memorable.

Experiment 2

The first experiment showed that the task is remembered longer when infants were trained and tested with +s than when they were trained and tested with either *L*s or *T*s. However, these results do not indicate whether certain textons (e.g., line crossings or terminators) are more memorable than others, as would be indicated by differential discrimination of *L*s, *T*s, and +s as the retention interval is increased. In Experiment 2, therefore, the time frame in which infants who were trained with +s would discriminate *L*s and *T*s (and vice versa) was examined by testing after intervals of 3, 5, or 7 days.

Also, the results of Experiment 1A suggest that the details of *L*s and *T*s, which differ in their number of terminators (*L*s have two, *T*s have three) as well as in the spatial arrangement of the black bars, are forgotten within 1 day. To determine whether infants could discriminate between these stimuli at all, we reduced the memory load, training infants with *L*s for 2 successive days and then testing with *T*s (or vice versa) only 1 hour after training on the second day.

Results revealed that infants discriminated between *L*s and *T*s after 1 hour (see Figure 3), but not after 24 hours because, presumably, they have forgotten either the number of line terminators or the different spatial relations between the horizontal and vertical line segments that distinguish *L*s from *T*s.

Infants who were trained with +s and tested with *L*s or *T*s (and vice versa) exhibited a significant recognition deficit after all delays (see Figure 4). In conjunction with the results of Exp. 1, the present results reveal that the detail of +s (the line crossing) are remembered for as long as the task is remembered, for 7 days, and mediate infants' discrimination of novel test displays over this entire period. However, even though the details distinguishing *L*s from *T*s were forgotten in less than 1 day, +s were discriminated from them for as long as they could cue the task, that is, for 3 days.

Experiment 3A

Bergen and Adelson (1988) found that decreasing the size of *L*s by 25% made them no longer discriminable when embedded in a field of +s. Experiment 3, therefore, was designed to test the possibility that infants' discrimination of *L*s from +s was due to differences in their perceived sizes. To this end, the size of *L*s was reduced by 25%--a manipulation which should eliminate infants' discrimination of *L*s from +s if a size-tuned mechanism was responsible for it. In

addition, to insure that the 25% reduction in size could in fact be detected, infants were trained with the original-sized *L*s and tested with reduced *L*s, and vice versa.

Results showed that infants in both groups discriminated the test mobile from the training mobile after 1 day (see Figure 5). Thus, in opposition to Bergen and Adelson's finding with adults, infants still discriminated *L*s and +s that were the same subjective size. Further, their discrimination between different-size *L*s indicated that the 25% reduction in size was noticeable and excluded the possibility that the amount of reduction was not sufficient to obtain the Bergen and Adelson size effect. We conclude, therefore, that differences in the complement of textons and/or their spatial arrangements must have mediated the discrimination.

Experiment 3B

Julesz's (1984) studies of texture segregation involved arrays whose local elements were randomly oriented and positioned to insure that segregation was due to differences in the number of perceptual units and not to differences in the orientation or position of the local elements in the textures. In Experiments 1 and 2, the orientation and position of each character had remained constant with respect to the square outline of each block's side. The possibility that infants' discrimination between *L*s and +s was due to differences in the absolute orientation and position of these characters on the blocks was examined in a final experiment by randomizing the orientation and position of these characters on the blocks comprising each mobile.

During testing 24 hours after training was over, infants again discriminated the *L*s from +s despite the fact that the orientation and position of the individual characters were randomized (see Figure 5). These results indicate that infants' discrimination of *L*s and +s was not based on differences in the orientation and position of the individual elements but on differences in the complement of textons and/or their spatial arrangements.

Conclusion

1) Infants remember +s, which are preattentively discriminated by adults, more than twice as long as *L*s or *T*s, which are not. Presumably this is due to the additional feature (a line crossing) in the +.

2) Infants discriminate a change in a single texton type for as long as the original mobile can cue retrieval of the task.

3) Infants' discrimination of *L*s and *T*s from +s is not the result of differences in the subjective sizes of these stimuli nor of differences in the orientation and/or position of the individual characters on the mobile blocks.

In conclusion, the same perceptual units or features that are preattentively discriminated by adults are remembered longer by infants. This suggests that the match between a current percept and the contents of long-term memory may be mediated by different features after different delays. From a more general perspective, these results suggest that both mnemonic and perceptual processes must be considered in any complete account of object recognition.

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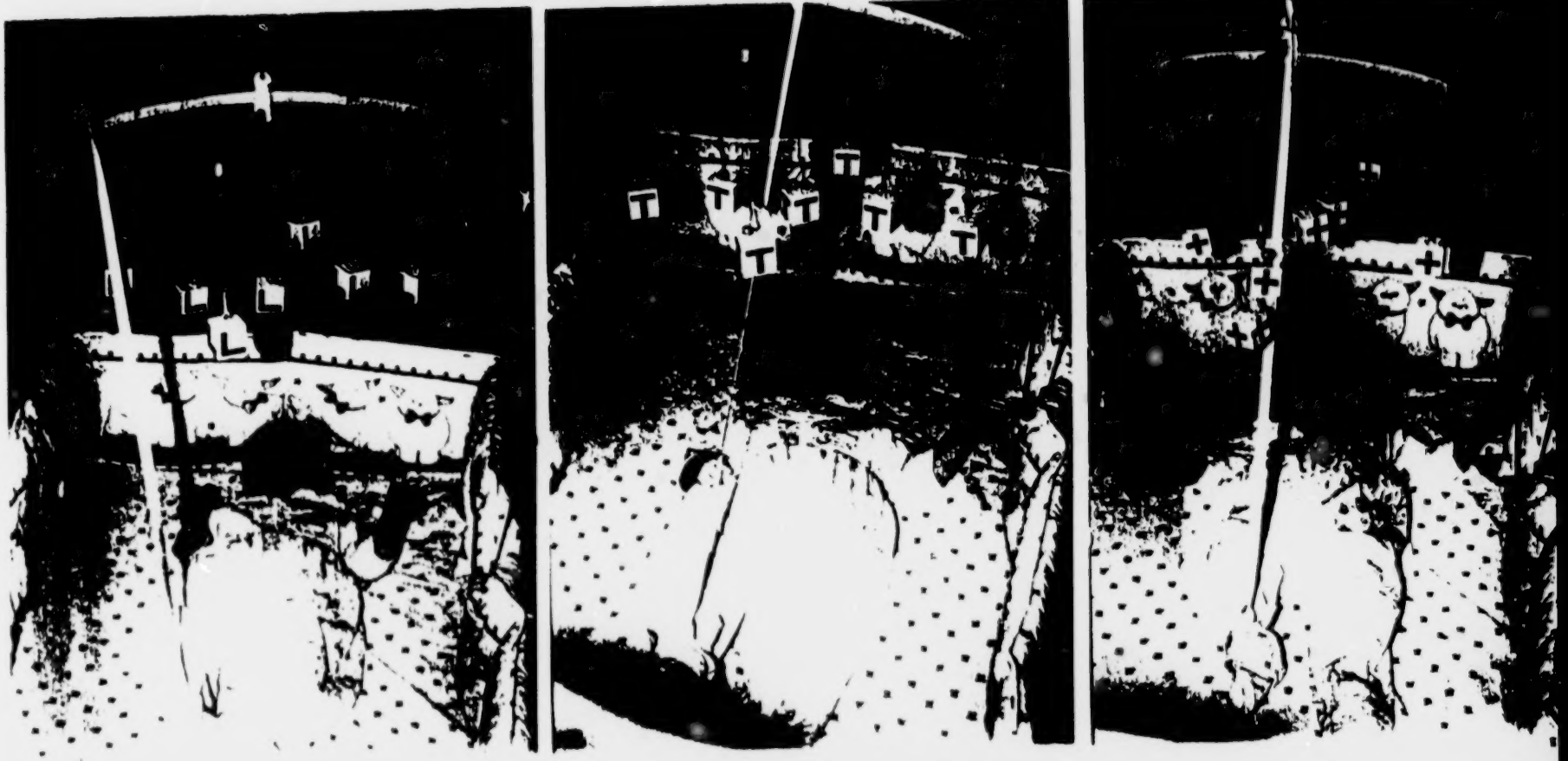

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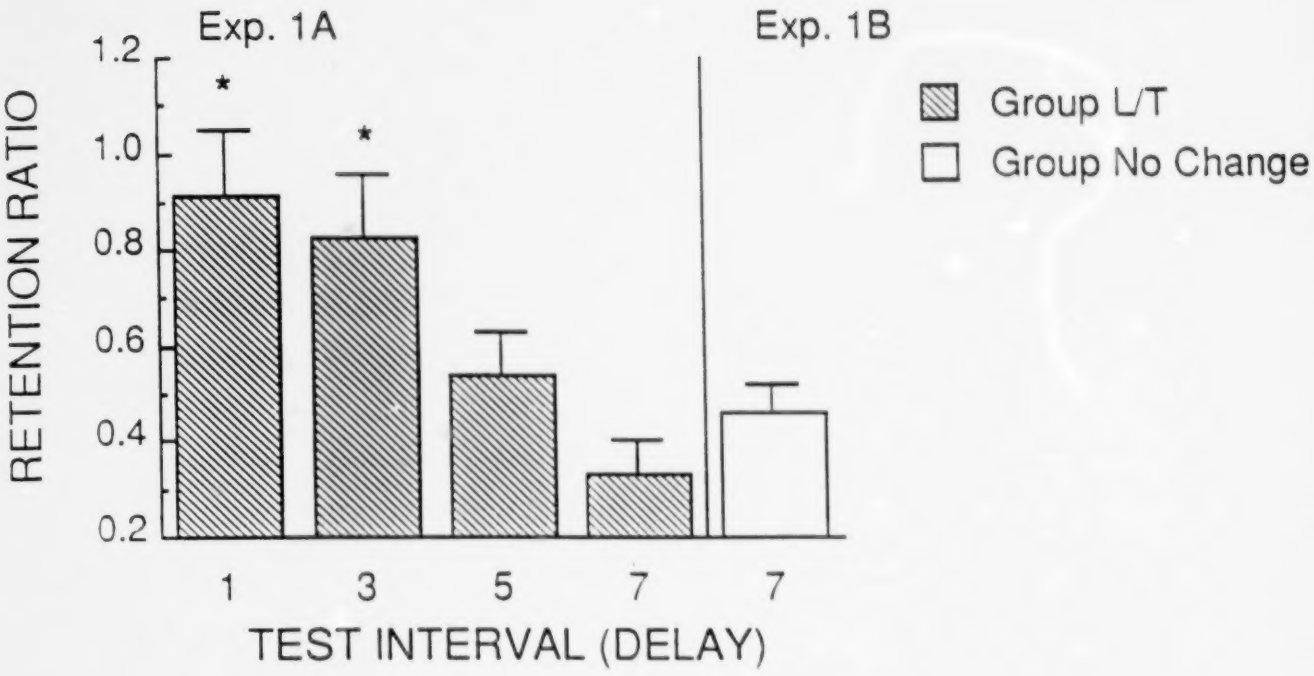
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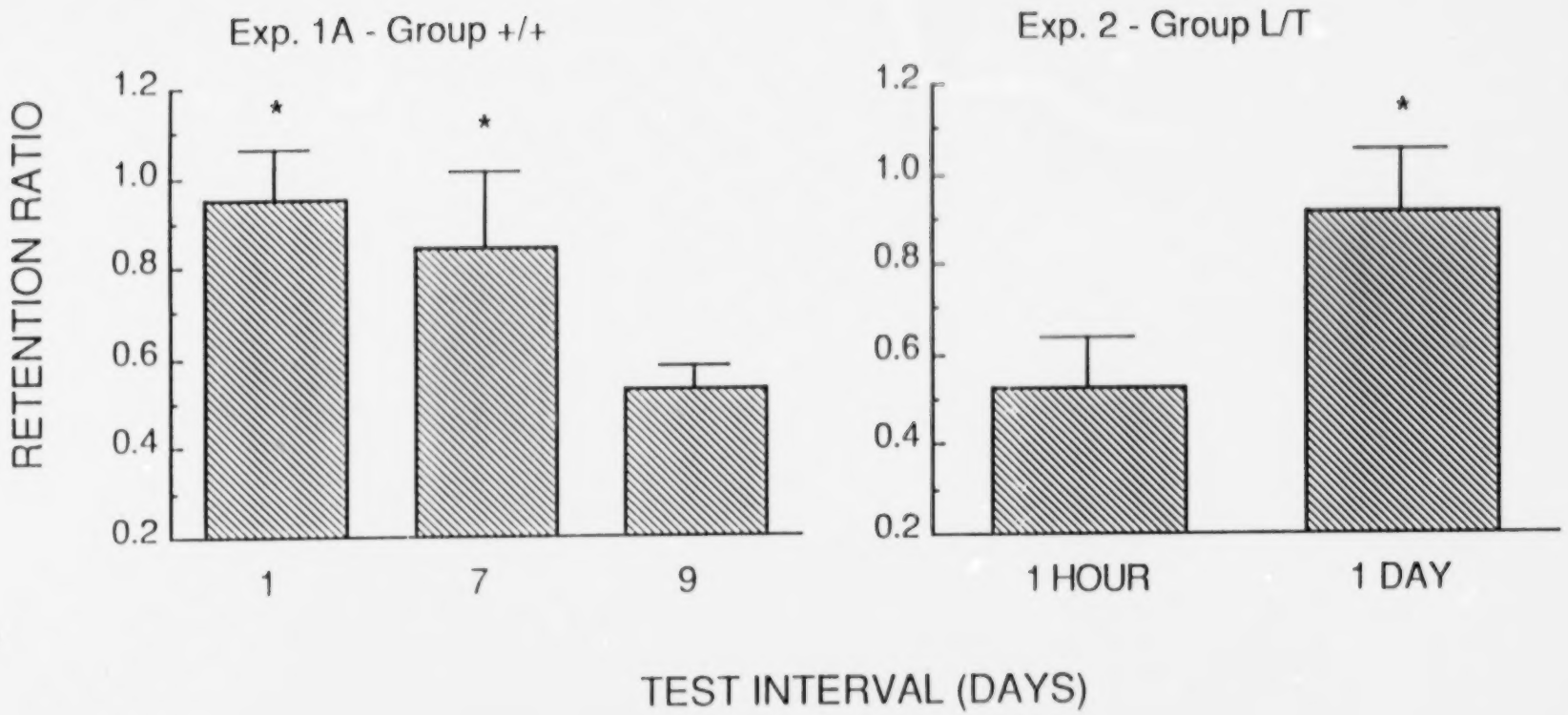
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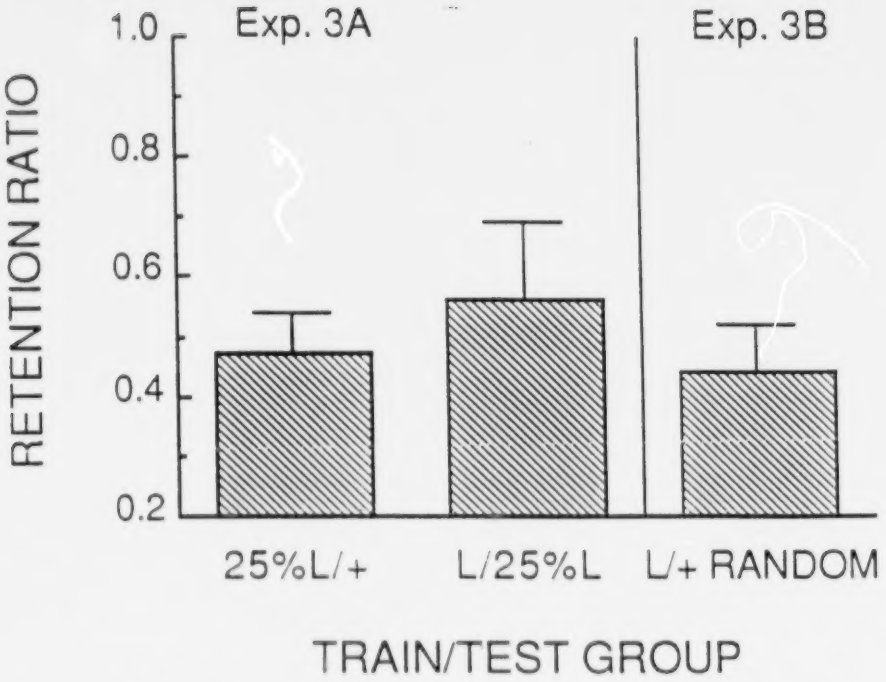
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